Appendix D

Supporting Analysis

Land Warrior

Program Studies and Analyses Summary

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Land Warrior Background

The Land Warrior program evolved from the Soldier Integrated Protective Ensemble Advanced Technology Demonstration (SIPE ATD). SIPE was successfully demonstrated during the fall of 1992, ending a three-year research effort. The most beneficial operational capabilities demonstrated by SIPE have been integrated into, and are the basis for, the Land Warrior program.

The Land Warrior mission need statement (MNS), prepared by the U.S. Army Infantry School, was approved by HQ, Department of the Army, on 8 September 1993. The Land Warrior program was approved for entry into phase 0 (concept exploration and definition) at the milestone 0 in-process review on 19 January 1994. The Land Warrior operational requirements document (ORD) was approved on 13 April 1994. Land Warrior was approved to proceed into engineering and manufacturing development (EMD) at the milestone I/II decision review on 26 August 1994.

After completion of a source selection evaluation board, the Land Warrior EMD contract was awarded to Hughes Aircraft Company (now Raytheon Electronics) on 11 July 1995. Implementation was delayed until 2 January 1996 due to a contract award protest. This protest was resolved in favor of the government and because subsequent Congressional language directed consolidation of the Land Warrior program and the Generation II Soldier Advanced Technology Demonstration. As a result of the consolidation, the Land Warrior EMD program continued forward and a science and technology program, called Force XXI Land Warrior, was initiated to pursue advanced technology efforts at the component level for subsequent insertion into the Land Warrior program.

A risk reduction exercise was conducted at Fort Benning, Georgia in April 1996 where soldiers evaluated the form, fit, and function of the preliminary Land Warrior program hardware. The resulting hardware design changes were verified during the second Land Warrior risk reduction exercise in September 1996. An eight-week early operational experimentation exercise was then conducted at Fort Benning during October and December 1996. Using ten surrogate prototype systems, data was collected from soldiers performing individual and collective Infantry tasks. Based on the data from this early operational experiment, further design changes were incorporated into the Land Warrior system that were approved at the preliminary design review conducted in February 1997.

The fiscal year 1997 budget provided funding to increase the planned Land Warrior procurement from 4,800 to 34,000 systems so that Land Warrior could be fielded to Infantry units in force package 1 and force package 2. As a result of this funding increase, Land Warrior was redesignated from an acquisition category (ACAT) III to an ACAT II program with the Army Acquisition Executive designated as the Milestone Decision Authority on 13 January 1997.

DAMO-FDZ

MEMORANDUM FOR ASSISTANT SECRETARY OF THE ARMY (RESEARCH, DEVELOPMENT AND ACQUISITION), ATTN: SARD-RP

SUBJECT: Mission Need Statement (MNS) for the Enhanced Integrated Soldier System Dismounted (TEISS-D)

1. The enclosed Mission Need Statement (MNS) for the Enhanced Integrated Soldier System – Dismounted (TEISS-D), also called Land Warrior, has been reviewed by the Army staff and is approved.

2. The Air Force and Navy have recommended the Joint Potential Designator be "Joint Interest".

3. The CARDS reference number is 17-93.

4. Request a Milestone Decision Authority (MDA) be assigned to accomplish the Milestone 0 (MS 0) actions as defined in the DoD 5000 series. Upon assignment, request this office be notified.

5. ODCOPS POC is Ms Frick, DSN 227-9712.

Encl

CF:
Secretary, Joint Requirements Oversight Council
Commander, U.S. Army Training and Doctrine Command,
ATTN: ATCD-M Ft. Monroe, VA 23651-5000
Deputy Chief of Staff for Operations and Plans,
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MISSION NEED STATEMENT (MNS)

FOR

LAND WARRIOR

1. Defense Planning Guidance Element. This capability need responds to Defense Planning Guidance, 1994-1999, section IV-C, dated 22 May 1992. This capability, to be called LAND WARRIOR, will significantly resolve capability issues 9, 16, 17, 21, 33, 34, 40, 57, 79, and 91, and will partially resolve capability issues 5, 7, 18, 19, 22, 43, 45, 54, 59, 72, 73, 85, 97, and 106 of the 1994-2008 Battlefield Development Plan dated 1 Nov 90.

2. Mission and Threat Analyses.

a. Mission Need. There is a need for improvement of five specific capabilities in support of the individual, dismounted, combat soldier: lethality, command and control (C2), survivability, mobility, and sustainment. LAND WARRIOR will improve the combat soldier capabilities in these five areas.

(1) Lethality. Land Warrior capabilities must provide the soldier a vision enhancement capability to accurately and effectively detect, classify, recognize, locate, and identify hard and soft targets during day, night, and periods of limited visibility beyond the range of the weapon being used.

(2) C2. Land Warrior must have secure voice communications; create, send, receive, and store information; display visual images to include digital maps and graphics; and transmit and receive position location information. Individual components should maximize hands-free operations and have the capability to filter excess information. The system must provide the soldier with situational awareness and combat identification.

(3) Survivability. The LAND WARRIOR must provide maximum protection, within the soldier's load limits, from small arms direct fire; antipersonnel mines; flame and incendiary weapons; effects of nuclear, biological, chemical (NBC), High Powered Microwave (HPM) and directed energy warfare; and fragments and flechettes resulting from indirect fires. The LAND WARRIOR should incorporate hearing protection. Land Warrior will prevent, disrupt, or deceive the threat's target detection/acquisition capabilities. It will provide Multi-threat warning devices. The survivability subsystem should impose less degradation of essential combat tasks than current protective equipment, including less degradation of essential combat tasks than current protective equipment, including less degradation of the soldier's senses, particularly peripheral vision, aural and touch. Additionally, the system should not create a significantly larger signature of the soldier than already exists.

(4) Mobility. The LAND WARRIOR must reduce the soldier's load when providing like capabilities using current equipment for a baseline. The LAND WARRIOR must be compatible with the requirements for mobility of all types of dismounted soldiers: airborne, air assault, mechanized, light, ranger, and special operations forces. Unit configuration will enable the soldier to carry only what is needed for a specific mission.

(5) Sustainment. Sustainment capabilities must support the soldier's ability to maintain himself in a tactical environment. The system must support the continuously protected soldier beyond current durations and must address a soldier's on hand supply/resupply needs for portable power, maintenance support, food, water, and munitions while using land warrior.

b. Threat Analysis.

(1) Threat to be Countered. The threat to be countered is primarily the threat infantry soldier and his combat and combat support systems. Threat systems may include any of the following: small arms, automatic weapons, tanks, ATGM, long range artillery, radio-electric combat systems, attack helicopters, and high performance aircraft. These systems will be able to deliver conventional munitions as well as mines, chemical and biological weapons, flechettes, bombs, electromagnetic and nuclear effects.

(2) Projected Threat Environment. Although the operational environment will vary, the LAND WARRIOR will always be subject to direct/indirect fire. The baseline threat document for the soldier system is the Individual Soldier Clothing and Equipment System Threat Assessment Report.

3. Non-materiel Alternatives. No changes in doctrine, operational concepts, tactics, organization, or training have been identified that can meet this need.

4. Potential Materiel Alternatives. There are no integrated systems in the world today that meet this need. However, there are numerous high pay off individual components and technologies that collectively could help meet this requirement.

a. Lethality. There are several items available using existing technology today that when integrated will improve the lethality of LAND WARRIOR. Potential items include: the thermal weapon sight, third generation image intensifier, modular weapon system with infrared aiming light, and a laser range finder.

b. Command and Control (C2). Technology within micro-electronics and palm sized components has drastically improved the ability to integrate several systems to enhance C2. Integration of squad level communication, heads-up display, video capture, global positioning system and the soldier computer, will add significant value to C2.

c. Survivability. Existing technology is available that will increase the survivability of LAND WARRIOR. These technologies could provide improved nuclear, biological

and chemical contamination protection; lighter and improved ballistic protective equipment; expanded laser eye protection; and advanced design combat uniforms.

d. Mobility. Using current equipment to provide similar capabilities would increase the soldier's load and adversely affect the soldier's mobility. LAND WARRIOR will provide the needed capabilities by producing smaller, lighter and integrated components.

e. Sustainment. Current equipment and supplies that sustain the infantry soldier are not integrated. With integration the infantry soldier's sustainment needs can be collectively and more effectively managed. Technology integration will reduce some sustainment issues, such as, supporting a single power source for several capabilities and fire control systems that increase accuracy and kill rates thereby decreasing the soldier's resupply requirement for ammunition.

f. Potential for Inter-Service or Allied Cooperation. The potential for allied cooperation is enhanced with the advent and approval of the North Atlantic Treaty Organization Soldier Modernization Plan, which includes a requirement for a system similar to the LAND WARRIOR. Developments under this MNS may be directly applicable to other U.S. services.

5. Constraints.

a. Logistics Support. The LAND WARRIOR must be supported by the standard Army maintenance, supply systems, and test, measurement, and diagnostic equipment, built-in test (BIT), and BIT equipment. The acceptable system operational availability goal is greater than 90 percent (95 percent is the desired system operational availability goal) when integrated with all other components of the LAND WARRIOR system.

b. Transportation. The system must be transported by the same means as the soldier. The system will be capable of unrestricted air, highway, rail, and marine transport worldwide. The system will be suitable for use by individual parachutists.

c. Mapping, Charting, and Geodesy Support. The system must be capable of accepting standard Defense Mapping Agency digital topographic data and must be interoperable with current and future, worldwide position location/navigation capabilities.

d. MANPRINT. The system design must accommodate the 5th percentile small female to the 95th percentile large male soldier. No increases in force structure, or new military occupational specialties/additional skill identifiers are anticipated. The LAND WARRIOR capabilities will require a change in training and evaluation methods.

e. System Interfaces and Compatibility. The C2 subsystem must be inter-operable with existing/developmental systems within the Army and other Department of Defense services (joint and combined). Storage security requirements for the LAND WARRIOR should not exceed those of individual weapons. The C2 enhancements must inter-operate

with digitized battlefield capabilities, battlefield identification and 2nd Gen. FLIR systems.

f. System Electronics. System electronics must be capable of surviving the effects of high altitude, electromagnetic pulse. The system electronics will not be affected by Electromagnetic Environmental Effects (E3).

g. Operational Environment. The system must be NBC contamination/decontamination survivable. It must be capable of functioning satisfactorily in both hot and basic climatic conditions.

6. Joint Potential Designator.

The Land Warrior MNS has a joint potential designator of "Joint Interest" from the Air Force and Navy.

1. NAME OF STUDY: Land Warrior Cost and Operational Effectiveness Analysis (COEA), 1994

2. DESCRIPTION OF STUDY (FOCUS): The purpose of the study was to conduct a cost and operational effectiveness analysis (COEA) of the Land Warrior in support of a milestone I/II decision in the 4th quarter of fiscal year 1994. The Army was to determine if the Land Warrior program should enter engineering, manufacturing and development (EMD) at this milestone.

3. ISSUES (CONSIDERED, RESOLVED, UNRESOLVED):

a. What are the changes in force effectiveness for each alternative? Unresolved; see paragraph 8, below.

b. What are the dollar costs associated with each alternative? Unresolved.

c. What are the logistical, training, personnel, and manpower impacts associated with each alternative? Unresolved.

d. What are the changes in the performance and operational effectiveness of the dismounted soldier for each alternative? Unresolved; see paragraph 8, below.

4. MODELS AND SIMULATIONS (LIMITATIONS): The most significant limitation in the two models used (CASTFOREM and Janus) was that the base case Infantry was not represented accurately. In both models, the base case Infantry units always knew the precise location and disposition of all friendly forces and always had perfect communications. The result of these limitations was that the base case units never got lost, never deviated from the most efficient routes, could accurately employ supporting fires, were in no danger of fratricide, and were very well coordinated in all their actions. In a sense, the base case looked much like the Land Warrior case.

a. Combined Arms and Support Task Force Evaluation Model (CASTFOREM). CASTFOREM was used for the platoon hasty defense, the platoon attack, and the company breaching operation.

b. Janus. Janus was used to model the company MOUT operation.

5. SCENARIOS (LOCATION, TIME FRAME, BLUE AND RED FORCES):

a. High resolution 33 formed the basis of the four vignettes used in the models. The postulated threat forces represented those expected in the year 2004.

b. Platoon hasty defense: A US light Infantry platoon, unsupported by vehicles, defends against a dismounted threat company attack.

c. Platoon attack: A US light Infantry platoon, unsupported by vehicles, attacks an entrenched threat squad.

d. Company breaching operation: A US light Infantry company, unsupported by vehicles, breaches a wire and mine obstacle defended by a threat squad or platoon.

e. Company military operations on urban terrain (MOUT): A US light Infantry company clears a "strip village" (village constructed along the length of a single primary road) which is defended by a threat platoon.

6. ALTERNATIVES:

a. The base case was the 1999 light Infantry soldier, as a member of a light Infantry squad, platoon, or company.

b. The alternative case was Land Warrior, in accordance with the Land Warrior draft operational requirements document dated 3 March 1994.

7. MEASURES OF EFFECTIVENESS (MOE): The following measures of effectiveness were to be employed to assess force and system effectiveness. Since this study was focused on dismounted soldier capabilities, "system" was defined to include dismounted soldiers.

a. Fractional exchange ratio. A ratio which compares the percentage of OPFOR killed to the percentage of US killed.

b. Loss exchange ratio. A ratio which compares the number of OPFOR killed to the number of US killed.

c. Specific exchange ratio. A ratio which compares the number of OPFOR killed by a specific US system to the number of that specific US system killed.

8. CONCLUSIONS: Inconclusive. The analysis was unable to show an operational difference between the base case and Land Warrior. The Department of the Army study advisory group concluded that the COEA was not appropriate at the time, and that the COEA should be considered a living document until such time that the models could be improved and/or new input data for the models could be developed.

9. OVERALL ASSESSMENT: The TRAC COEA report was never completed. The study plan and some appendices exist.

10. KEY FOLLOW ON REVIEWS TO THE STUDY: In March 1994, the DA study advisory group tasked the U.S. Army Materiel Systems Analysis Activity (AMSAA) to conduct a performance analysis of Land Warrior to supplement the COEA.

1. NAME OF STUDY: Land Warrior Performance Analysis, September 1994

2. DESCRIPTION OF STUDY (FOCUS): The analysis focused on isolating and assessing the contribution to battle outcome provided by separate items and by combinations of Land Warrior equipment items. The analysis compared capabilities of similar systems which included current and developmental systems in relevant combat scenarios with emphasis on assessment at the system, soldier, squad, and platoon levels.

3. ISSUES (CONSIDERED, RESOLVED, UNRESOLVED):

a. What is the combat effectiveness value added to Infantry by individual items of Land Warrior equipment? Resolved.

b. What is the combat effectiveness value added to Infantry by combinations of Land Warrior items of equipment? Resolved.

4. MODELS AND SIMULATIONS (LIMITATIONS):

a. ACQUIRE: Calculates the probabilities of detection, recognition, and identification for optical and infrared sensors for various environments.

b. P HIT: Calculates the first round hit probability of free flight projectiles.

c. F-BAR: Estimates the effectiveness of a burst fire weapon against personnel targets.

d. CASRED: Evaluates the protective capability of helmets and body armor against fragmenting weapons.

e. ARTQUICK: Computes the fractional casualties of a target area from fragmenting munitions.

f. TCORE: Predicts heat stress casualties based on body core temperatures due to work rate, clothing and environmental conditions.

g. FIREFIGHT: Determines the effects of a mix of Infantry weapons in a force-on-force simulation with a defending squad and an attacking platoon consisting of a maneuver element, a base of fire element, and a reserve element.

h. GWARS: A two sided stochastic model, which simulates a ground duel between two homogeneous forces.

5. SCENARIOS (LOCATION, TIME FRAME, BLUE AND RED FORCES): A U.S. Infantry platoon attacks an enemy squad during a clear (7 Km) day on terrain consisting of minimal vegetation and a constant 10% uphill slope. Initial engagement ranges were

700 meters for the base of fire element, and 500 meters for the maneuver element. Various angles of attack were employed.

6. ALTERNATIVES:

a. The base case was the 1994 light Infantry soldier.

b. Alternative 1 was the 1999 light Infantry soldier.

c. Alternative 2 was the 2003 Land Warrior.

7. MEASURES OF EFFECTIVENESS (MOE): The following measures of effectiveness were employed to assess force and system effectiveness.

a. Probability of recognition; probability of hit.

b. Friendly and enemy casualties from direct and indirect fires; fratricide.

c. Time to complete mission.

d. Contribution of reduced exposure to survivability.

e. Movement rate.

8. CONCLUSIONS: "The Land Warrior System (composed of 13 individual developmental and fielded systems) demonstrates the potential for significant improvement in the combat capability of the dismounted infantry soldier and should proceed into the developmental and user test phases."

9. OVERALL ASSESSMENT: The performance analysis showed that the Land Warrior equipment had the potential to provide a significant improvement in the dismounted soldier battle.

10. KEY FOLLOW ON REVIEWS TO THE STUDY: None noted.

1. NAME OF STUDY: Reliability and Maintainability Requirements Rationale for the Land Warrior System, December 1995

2. DESCRIPTION OF STUDY (FOCUS): To analyze the reliability and operational availability of Land Warrior components in conjunction with the materiel developer's technical feasibility analysis of Land Warrior reliability and maintainability.

3. ISSUES (CONSIDERED, RESOLVED/UNRESOLVED):

4. MODELS AND SIMULATIONS (LIMITATIONS):

a. Logistical Support Analysis Data Record "A"

b. Materiel Developer's Technical Feasibility Analysis of Land Warrior Reliability and Maintainability.

c. Mission Profiles.

d. Operational Mode Summaries.

5. SCENARIOS (LOCATION, TIME FRAME, BLUE AND RED FORCES):

a. Military Operations on Urbanized Terrain (MOUT)—Attack. This MOUT attack mission depicts an air assault battalion participating in a brigade attack to clear a city defended by a threat light Infantry battalion.

b. MOUT defense. An air assault battalion conducts a hasty defense against a threat heavy force counterattack.

c. Night attack. An airborne brigade (minus) attacks a battalion size threat force.

d. Defense. An air assault battalion defends against a threat motorized rifle brigade counterattack.

e. Rear area operation. A light Infantry battalion provides security for Corps Support Command elements near a port city in the theater of operations.

f. Civil affairs support. An airborne battalion's rifle squad conducts a road block at a check point.

6. ALTERNATIVES: Land Warrior equipment, based on the Land Warrior operational requirements document.

7. MEASURES OF EFFECTIVENESS (MOEs): Mission reliability, mean time between mission abort, mean time between mission affecting failure, mission duration, operational availability, and failure data from existing systems.

8. CONCLUSIONS: The levels of reliability and maintainability that the Land Warrior system is expected to achieve are summarized below. These requirements were considered to be technologically feasible, based on comparison to the technological reliability and maintainability thresholds that the materiel developer had projected for the system.

Reliability

Mean Time Between Mission Abort: > 900 System Op Hours

Mean Time Between Mission Affecting Failure: > 110 System Op Hours

Maintainability

Mean Time To Repair: < 0.73 Hours

Maintenance Ratio: < 0.020 Maintenance Man Hours/System Op Hour

9. OVERALL ASSESSMENT: The mean time between mission affecting failure, and maintainability requirements are based on the operational availability constraint for the Land Warrior system. The operational availability of the Land Warrior system is greater than or equal to 0.90 in order to provide assurance that the system will be capable of achieving the required readiness status for category I combat units (90% - 100% combat ready). Since this constraint has established the operational availability of the Land Warrior system, its inherent reliability and maintainability attributes must provide the capability required to achieve the specified operational availability.

10. KEY FOLLOW ON REVIEWS TO THE STUDY. The reliability and maintainability report is currently being updated in view of results obtained from the Joint Contingency Force Advanced Warfighting Experiment.

1. NAME OF STUDY: Land Warrior Risk Reduction 1 Results, May 1996

2. DESCRIPTION OF STUDY (FOCUS): This risk reduction was conducted to provide early feedback to designers and integrated product teams concerning the suitability and acceptability of Land Warrior concepts and components so that data based mid-course corrections could be made prior to the Early Operational Experimentation.

3. ISSUES (CONSIDERED, RESOLVED/UNRESOLVED): The Land Warrior risk reduction analysis addressed four developmental issues.

a. Land Warrior component physical interfaces. The fit of Land Warrior components to each other and to the soldier.

b. The suitability of the weight, shape, and volume of Land Warrior components.

c. Mobility and agility. Does Land Warrior impact the soldier's range of movement, mobility, or agility?

d. The soldier-computer interface. A preliminary user evaluation of the look and feel of the Land Warrior soldier-computer interface and the usability of the remote input pointing device interface.

4. MODELS AND SIMULATIONS (LIMITATIONS) 31 live soldiers from 3rd Brigade of the 24th Infantry Division (renamed the 3rd Infantry Division) and the 1/507th Parachute Infantry Regiment participated in the exercises.

5. SCENARIOS (LOCATION, TIME FRAME, BLUE AND RED FORCES): Risk reduction 1 was conducted at Fort Benning, Georgia, during the period 15-19 April 1996. Participants were put through exercises such as the following.

a. Range of movement: Calisthenics-like drills intended to assess whether Land Warrior components restrict essential soldier agility and mobility.

b. Firing positions: Standard firing positions (standing, kneeling, prone, etc.) while wearing Land Warrior equipment, Land Warrior weapons, and non-Land Warrior Infantry weapons.

c. Vehicle ingress and egress. HMMWV and Bradley Fighting Vehicles. Participants were assessed in terms of their ability to get into and out of these vehicles while wearing Land Warrior equipment.

d. Cross country movement. A 300 meter, cross country movement at normal walking speed, and over a series of natural and man made obstacles, was used to determine if Land Warrior equipment caused hot spots, chaffing, or snagging.

e. Parachute harness compatibility. Participants donned and doffed a standard parachute harness to determine its compatibility with the Land Warrior equipment.

f. MOPP compatibility. Participants donned and doffed the Xm-45 mask while wearing Land Warrior equipment. Assessments were also made in terms of their ability to access and manipulate Land Warrior components and controls while wearing NBC protective gloves.

6. ALTERNATIVES: Live soldiers equipped with Land Warrior prototype equipment.

7. MEASURES OF EFFECTIVENESS (MOEs):

a. MANPRINT and other subject matter expert observations pertaining to each of the risk reduction issues.

b. Soldier comments (unsolicited comments and interview results) relating to each of the risk reduction issues.

c. Usability questionnaire. Results from a structured questionnaire addressing Land Warrior component usability and related risk reduction issues.

8. CONCLUSIONS: Risk Reduction 1 results did indicate one potential show stopper--the integrated helmet subsystem. (note: modifications to the helmet, mount, and ballistic vest have been made)

a. It was too large and inflexible.

b. Its placement interfered with the weapon sights on the modular weapon system.

c. Its size and location interfered with the effective use of other Infantry weapons. Additionally, the electronics module on the back of the helmet was not compatible with the ballistic vest.

9. OVERALL ASSESSMENT:

a. The risk reduction assessment was a successful exercise. A variety of problems that will impact upon the Land Warrior system's effectiveness, suitability, and acceptability to soldiers were identified. Most of these problems were not show stoppers in the sense that they would produce serious problems by themselves. Collectively, the minor problems could lead to a situation in which soldier performance and system acceptability would be negatively affected.

10. KEY FOLLOW ON REVIEWS TO THE STUDY. None noted.

1. NAME OF STUDY: Land Warrior Early Operational Experimentation, October – December 1996

2. DESCRIPTION OF STUDY (FOCUS): The Land Warrior Early Operational Experimentation was conducted as a major risk reduction exercise to allow the contractor and the Government to examine equipment, software, and human factors issues. The exercises also allowed the U.S. Army Infantry Center to explore the potential combat effectiveness of Land Warrior, and to develop doctrine and tactics for the employment of Land Warrior during initial operational tests and experiments, and to identify training requirements for Land Warrior soldiers and units. Results of the Early Operational Experimentation formed the basis for a mid-course correction of the system and program requirements.

3. ISSUES (CONSIDERED, RESOLVED/UNRESOLVED): Identify those areas where the Land Warrior prototype is found to be deficient so that potential design changes can be explored in a timely fashion.

4. MODELS AND SIMULATIONS (LIMITATIONS): Live soldiers and Land Warrior prototype systems were used during the experiment.

5. SCENARIOS (LOCATION, TIME FRAME, BLUE AND RED FORCES): The Early Operational Experimentation consisted of an Infantry squad plus a platoon leader, platoon sergeant, two additional squad leaders, and two additional soldiers for a total of 15 personnel. After receiving training on the use of the Land Warrior prototypes, the unit participated in a series of events designed to assess individual and collective task performance and concluded with operational missions. At the end of individual tasks, a live fire exercise was conducted. The experimentation culminated with two 48 hour platoon level exercises: one using current equipment, and one with Land Warrior prototype equipment.

6. ALTERNATIVES: The experimentation operator course was taught during the first week, instructing the students in the operations of the Land Warrior prototypes using 80% hands-on training. The soldiers were administered a performance oriented test after the operator course to baseline the training. The soldiers then conducted individual/leader common and Infantry tasks. The tasks selected for evaluation were the building blocks for subsequent experiments involving collective tasks.

7. MEASURES OF EFFECTIVENESS (MOEs): Common and Infantry tasks, conditions, and standards.

8. CONCLUSIONS:

a. Results of the cognitive acceptability tests clearly indicated that the soldiers experienced no difficulties with the level of cognitive ability required to operate Land Warrior. For example, they found that the soldier computer interface was easy to

understand and use. Additionally, they liked the enhanced capabilities provided by the Land warrior and understood the concept.

b. Results of the physical acceptability tests indicated that the physical interfaces of the ensemble needed work. For example, the protective clothing and individual equipment was not merely uncomfortable, but was, in some cases, painful to wear. Additionally, the shortfalls in the durability and reliability of the ensemble dampened their acceptability of the physical design.

c. Command and control were greatly improved with Land Warrior over the base case. Leaders no longer had to move on the battlefield to disseminate information. This provided greater survivability. The soldiers' situational awareness allowed them to better react to changing conditions and play a more active role in small unit operations, thus increasing the lethality of their unit.

d. Lethality was greatly increased with Land Warrior. Sensor capability coupled with accurate position location (with the laser range finder and digital compass), and communications allowed for precise direct and indirect fire upon the enemy. These same sensors and intra-squad communications allow the soldiers to see the enemy first and provide this same situational awareness to all team members.

9. OVERALL ASSESSMENT: The Land warrior Early Operational Experimentation was a total success. This was the first major iteration of an iterative development process which follows a test-fix-test sequence. It was not intended to be a pass-fail exercise. The experimentation was an important part of the test-fix-test strategy, and was one of a series risk reduction exercises. This was a narrowly defined experiment conducted at one installation with one of the five types of Infantry executing a subset of their assigned missions with Land Warrior prototypes that were partially functional. Significant gaps in our knowledge base remained to be explored during future evaluations of the Land Warrior prototype system.

10. KEY FOLLOW ON REVIEWS TO THE STUDY. None noted.

1. NAME OF STUDY: Manpower and Personnel (MANPRINT) Assessment (Abbreviated) for the Land Warrior, Oct 1998

2. DESCRIPTION OF STUDY (FOCUS): The purpose of the abbreviated MANPRINT assessment was to highlight issues and concerns and to recommend solutions for the Land Warrior system.

3. ISSUES (CONSIDERED, RESOLVED/UNRESOLVED): MANPRINT issues associated with manpower, personnel, training, human factors engineering, health hazards, and soldier survivability were examined.

4. MODELS AND SIMULATIONS (LIMITATIONS): Live soldiers, Land Warrior prototype systems, and previous experiments and risk reduction exercises completed during the previous two years.

5. SCENARIOS (LOCATION, TIME FRAME, BLUE AND RED FORCES): Infantry squads conducting common and Infantry tasks in cognitive and physical exercises.

6. ALTERNATIVES: Infantry personnel equipped with Land Warrior mock-up and prototype components.

7. MEASURES OF EFFECTIVENESS (MOEs): Common and Infantry tasks, conditions, and standards.

8. CONCLUSIONS:

a. Manpower: Amber-red. Maintaining, storing, transporting, and sustaining the quantities of disposable or rechargeable batteries required for Land Warrior is expected to require additional manpower, according to the Level Of Repair Analysis. Further analysis of basis of issue plan feeder data, and other references, shows that one soldier will require 22 disposable batteries (total weight 12.8 pounds, plus another pound for the rechargeable battery backup) for a 48 hour continuous operation. A platoon will require 873 batteries (524 pounds), and a company will require 3,046 batteries (1,828 pounds). Resupply sorties, whether by air or ground, will be required in order to avoid an increase in the soldier's load. Additional generators, recharger units, HMMWVs or other trucks to carry this equipment and additional fuel to power the equipment, will require additional drivers and generator operators—numbers yet to be determined. (note: In the two years since this report, the Land Warrior's battery weight has decreased significantly, and its battery life has been dramatically extended.)

b. Personnel: Green. Numerous risk reduction activities using prototype equipment have been conducted using target audience soldiers. User jury assessments of the soldier-computer interface software have also been conducted. Target audience soldiers have demonstrated an aptitude for learning and operating the Land Warrior computer and other subsystems.

c. Training: Amber. Courses of instruction for operators, leaders, tactics, unit maintenance, and direct support maintenance have been developed to include updated training publications (e.g., Field Manuals). However, these courses and publications have not been updated to correspond with the latest Land Warrior configuration; nor have they been validated and tested for effectiveness by the government. (notes: These updates are in progress as of Nov 00. Validation experiments are currently being planned by the DTLOMS integrated work group, using working, version 0.6, Land Warrior prototypes.)

d. Human factors engineering: Red. The system evaluated did not allow the full range of soldiers to assume a correct prone firing position. The helmet and helmet cable, body armor, and upper electronic component housing came in contact with each other to varying degrees. Contact of these components at the base of the neck prevented some individuals from acquiring and maintaining a sight picture with the weapon-mounted sights in a prone firing position. (note: These configurations have all been changed since this evaluation. Modifications in the helmet, body armor, modular lightweight load bearing equipment, and cabling, have corrected these problems.)

e. Health hazards: Amber. The Land Warrior squad leader's assault load weighs 86 pounds while today's squad leader's load is 80 pounds. Additional batteries required for missions, which exceed 2.5 hours will increase the load, depending upon resupply rates. (note: Land Warrior's load in 2000 is actually less than the 1998 soldier's load.)

f. Soldier survivability: Amber. The vulnerability of Land Warrior to detection by natural senses and the full range of sensors have not been tested. The Land Warrior computer system may be vulnerable to sabotage through the insertion of malicious viruses, worms, and codes. The Land Warrior's helmet chin strap had a rigid fastener similar to the PASGT helmet; consequently, testing and analysis are required to determine if the current helmets are a potential source of injury to soldiers when exposed to blast overpressure.

9. OVERALL ASSESSMENT: This MANPRINT assessment did an excellent job of pointing out many of the problems associated with the early mockups and partially working Land Warrior prototypes. Most of the problems described above have been corrected, or modifications are in progress to make the corrections. A complete MANPRINT assessment, including detailed individual domain assessment, will be completed for the milestone III decision review.

10. KEY FOLLOW ON REVIEWS TO THE STUDY. None noted.

1. NAME OF STUDY: Land Warrior Capability Analysis, March 1999

2. DESCRIPTION OF STUDY (FOCUS): A force effectiveness comparison of Land Warrior's capabilities in two different basis of issue alternatives, and a year 2002 Airborne Infantry platoon and company.

3. ISSUES (CONSIDERED, RESOLVED, UNRESOLVED):

a. Estimate the operational impact of Land Warrior capabilities on the force. Issue resolved. Land Warrior capabilities provide Infantry units with a clear and significant advantage over non Land Warrior forces in the areas of command and control, lethality, survivability, mobility, and situation awareness.

b. Is there an improvement in the force when selected Land Warrior capabilities are distributed below fire team leader level? Issue resolved. The use of force-on-force simulations showed a decided increase in overall effectiveness of U.S. forces directly due to the increased distribution of Land Warrior capabilities.

4. MODELS AND SIMULATIONS (LIMITATIONS):

a. The Integrated Unit Simulation System (IUSS) is a force-on-force model developed and used at the Soldier and Biological Chemical Command, Natick, Massachusetts. It is capable of modeling Infantrymen as individuals in company and below scenarios. It was used in this analysis to model a U.S. Infantry company offense and a U.S. Infantry platoon defense.

5. SCENARIOS (LOCATION, TIME FRAME, BLUE AND RED FORCES):

a. Company offense. This scenario took place on terrain located at Fort Benning, Georgia, in the general vicinity of McKenna MOUT site. It consisted of a year 2002 Airborne Infantry company conducting a search and attack, followed by a fragmentary order to conduct a night attack on an enemy squad size force in the vicinity of McKenna MOUT site.

b. Platoon defense: A year 2002 U.S. Airborne Infantry platoon, conducts a road clearing operation, at night, in the vicinity of McKenna MOUT site. Upon receiving a report of a small, enemy force to their front, the platoon prepares and conducts a hasty defense.

6. ALTERNATIVES:

a. Base case: The base case was a year 2002 Airborne Infantry company. This base case was chosen specifically because it would represent a force which had many of Land Warrior's capabilities fielded by this time. It was the toughest, and fairest, base case to compare to a Land Warrior equipped force.

b. Alternative 1 was the same unit equipped with Land Warrior systems down to the fire team leaders. This included appropriate Land Warrior capabilities at battalion, company, platoon headquarters, squad leaders and fire team leaders. Infantrymen below fire team leader were not equipped with Land Warrior systems.

c. Alternative 2 was the same unit equipped with Land Warrior systems throughout the platoon and company. All members of the company, platoons, squads, and fire teams were equipped with Land Warrior systems.

7. MEASURES OF EFFECTIVENESS (MOE): The following measures of effectiveness were to be employed to assess force and system effectiveness.

a. U.S. and opposing force casualties by direct and indirect fires.

b. Duration of the engagement.

c. Time to execute troop leading procedures (platoon defense only).

d. Ammunition expended.

8. CONCLUSIONS:

a. Significant force effectiveness improvements occur when Land Warrior capabilities are available to the force.

b. Force effectiveness continues to improve as the Land Warrior distribution density increases.

9. OVERALL ASSESSMENT: This was the first force effectiveness analysis of alternatives, which not only compared Land Warrior to a tough base case, but also looked at two different distributions (basis of issue alternatives) of Land Warrior within the Infantry organization. It clearly showed that the combat effectiveness of the force continues to improve as the distribution density of Land Warrior increases.

10. KEY FOLLOW ON REVIEWS TO THE STUDY: None noted.

1. NAME OF STUDY: Land Warrior Analysis of Key Performance Parameters, July 1999

2. DESCRIPTION OF STUDY (FOCUS): Analysis of Land Warrior's key performance parameters—command and control, reliability, power, and weight. In addition to the force effectiveness modeling done at TRAC-WSMR in direct support of this analysis of key performance parameters, this analysis also used recently completed studies and analyses to support its conclusions. These additional studies were: the Land Warrior Capability Analysis; AMSAA's 1994 Land Warrior Performance Analysis; the 1996 Reliability and Maintainability Report on Land Warrior; the 1997 Energy-Efficient Technologies for the Dismounted Soldier report by the Committee on Electric Power for the Dismounted Soldier, Board on Army Science and Technology; and Field Manual 21-18 on Foot Marches, data from the Joint Readiness Training Center, and other studies.

3. ISSUES (CONSIDERED, RESOLVED, UNRESOLVED):

a. Command and control: Land Warrior software will integrate and manage system functions and implement joint variable message formats in compliance with the Army's joint technical architecture. Issue resolved. Improved command and control generally resulted in improved U.S. survivability, lethality, mobility, and coordination.

b. Reliability: The Land Warrior system must demonstrate a .80 probability of completing the longest wartime mission identified in the operational mode summary and mission profile without incurring a mission affecting failure as defined in the reliability failure definition and scoring criteria. Issue resolved. In addition to a reliability of .80 being technologically feasible for Land Warrior, a reliability of .80 is essential to guarantee a CAT-1 readiness category for Land Warrior systems and units.

c. Power: Noiseless power sources will power the computer radio system which will employ power management. Power requirements will be time phased to meet system operational requirements. Issue resolved.

Time Phase	Key Performance Parameter
Initial Production (IP) (1QFY03)	12 Mission Hours, Weight 1.6 pounds
IP + 2.5 Years (3QFY05)	48 Mission Hours, Weight 1.0 Pounds
IP + 5.0 Years (1QFY08)	72 Mission Hours, Weight 0.5 Pounds

These power requirements are achievable according to Energy-Efficient Technologies for the Dismounted Soldier, Committee on Electric Power for the Dismounted Soldier, Board on Army Science and Technology, Commission on Engineering and Technical Systems, National Research Council, National Academy Press, Wash., D.C., 1997.

d. Weight: Land Warrior will replace equipment items (capabilities) and provide enhanced capabilities while not increasing the weight of a typical soldier's combat load. Issue resolved. The Land Warrior operational requirements document may be the only current document that actively seeks to enforce a prohibition on load increases,

recommended by FM 7-8, FM 7-10, FM 21-18, the Soldier and Biological Chemical Command's technology demonstration for lightening the soldier's load, the National Research Council, and practically every study that has ever been done on soldier's load.

4. MODELS AND SIMULATIONS (LIMITATIONS):

a. The Integrated Unit Simulation System (IUSS) is a force-on-force model developed and used at the Soldier and Biological Chemical Command, Natick, Massachusetts. It is capable of modeling Infantrymen as individuals in company and below scenarios. It was used in this analysis to model a U.S. Infantry company offense and a U.S. Infantry platoon defense.

b. The Soldier Station simulation at the TRADOC Analysis Center – White Sands Missile Range (TRAC-WSMR) was used to model a U.S. Infantry platoon offense. Soldier Station is a virtual simulation, which uses live personnel to interact within the scenario. Live personnel held the positions of two fire team leaders, a squad leader, and a platoon leader. All other U.S. and opposing force were simulated by computer generated forces provided by the Janus force-on-force model.

5. SCENARIOS (LOCATION, TIME FRAME, BLUE AND RED FORCES):

a. Company offense. This scenario took place on terrain located at Fort Benning, Georgia, in the general vicinity of McKenna MOUT site. It consisted of a year 2002 Airborne Infantry company conducting a search and attack, followed by a fragmentary order to conduct an attack on an enemy squad size force in the vicinity of McKenna MOUT site.

b. Platoon defense: A year 2002 U.S. Airborne Infantry platoon, conducts a road clearing operation in the vicinity of McKenna MOUT site. Upon receiving a report of a small, enemy force to their front, the platoon prepares and conducts a hasty defense.

c. Platoon Offense: A U.S. Airborne Infantry platoon, conducting a search and attack, makes contact with, and attacks, an enemy squad in the vicinity of a small town.

6. ALTERNATIVES:

a. For the company offense and platoon defense, the base case was a year 2002 Airborne Infantry company. Alternative 1 was the same unit equipped with Land Warrior systems down to the fire team leaders. Alternative 2 was the same unit equipped with Land Warrior systems throughout the platoon and company.

b. For the platoon offense, the base case was an Airborne Infantry platoon equipped with Land Warrior systems, but without the capability of Force Twenty One Battle Command for Brigade and Below (FBCB2); and consequently, without the capability to use joint variable message formats or the Army's joint technical architecture. The

alternative case consisted of the same Land Warrior Airborne Infantry platoon, with the addition of FBCB2/JVMF capabilities.

7. MEASURES OF EFFECTIVENESS (MOE): The following measures of effectiveness were to be employed to assess force and system effectiveness.

a. U.S. and opposing force casualties by direct and indirect fires.

b. Ammunition expended.

b. Duration of the engagement.

c. Time to execute troop leading procedures (platoon defense only).

8. CONCLUSIONS: Land Warrior's key performance parameters are achievable, justified, and supported by several recent studies and analyses.

9. OVERALL ASSESSMENT: This analysis was briefed to MG Zanini, Deputy Chief of Staff for Combat Developments, in May 1999. It was used to support the Land Warrior operational requirements document which was approved and signed by General Abrams, Commander, Training and Doctrine Command, on 3 August 1999.

10. KEY FOLLOW ON REVIEWS TO THE STUDY: None noted.

1. NAME OF STUDY: Joint Contingency Force Advanced Warfighting Experiment, September 2000 (Unofficial Results)

2. DESCRIPTION OF STUDY (FOCUS): The Land-Warrior-equipped 2nd platoon, C Company, 3rd Battalion, 325th Airborne Infantry Regiment from Fort Bragg, North Carolina, conducted force-on-force exercises at the Joint Readiness Training Center, Fort Polk, Louisiana. to demonstrate the potential of Land Warrior equipped forces to increase combat effectiveness in survivability, lethality, and situational awareness. Operations conducted included a parachute assault, a search and attack operation, an attack in urban terrain, and an ambush.

3. ISSUES (CONSIDERED, RESOLVED, UNRESOLVED): If contingency forces incorporate Land Warrior systems across the DTLOMS, then these forces will realize increased combat effectiveness in survivability, lethality, and situational awareness. Issue resolved.

4. MODELS AND SIMULATIONS (LIMITATIONS):

a. A platoon of live soldiers from 2/C/3-325 Airborne Infantry Regiment, equipped with version 0.6 prototype Land Warrior systems conducted a parachute assault into the Joint Readiness Training Center, followed by force-on-force operations. Observer-controllers, data recorders, data collectors, data verifiers, and analysts were on hand during the operations. The 45 Land Warrior systems were used by the following personnel during the experiment:

2d Platoon, C Company:		35 (4 le
Platoon Medic:		
Platoon Forward Observer		1
Company Commander		1
Radio Telephone Operators		2
Company Executive Officer	1	
Company First Sergeant		1
Company Fire Spt Team		1
Co. Mortar Section Leader		1
Sapper Squad Leader		

b. MILES 2000 was used to simulate the results of live fire during the search and attack operation.

c. Live fire (using short range training ammunition) was used during the night MOUT attack.

d. Live fire was used during the Land Warrior platoon's conduct of an ambush.

5. SCENARIOS (LOCATION, TIME FRAME, BLUE AND RED FORCES): In September 2000, at the Joint Readiness Training Center, 2/C/3-325 AIR executed the following scenarios.

a. Search and attack. The Land Warrior platoon conducted a parachute assault on D-Day, followed by an initial ground assault to establish a lodgment, and a search and attack to expand the lodgment (D+1, 2, 3). MILES 2000 was used to simulate live fire. The platoon encountered and eliminated an enemy sniper team.

b. Night MOUT attack. The Land Warrior platoon and sapper squad planned, prepared, and executed a night MOUT attack on D+4, 5, using short range training ammunition.

c. Night Ambush. The Land Warrior platoon and sapper squad planned, prepared, and executed a live fire night ambush.

6. ALTERNATIVES:

a. Base case: The base case at JRTC consists of historical data (similar platoons conducting similar exercises in the past), and similar platoons conducting similar operations during the Joint Contingency Force Advanced Warfighting Experiment.

b. Alternative 1 consisted of the live platoon of soldiers from 2/C/3-325 AIR, equipped with version 0.6 Land Warrior prototype systems.

7. MEASURES OF EFFECTIVENESS (MOE): The following measures of effectiveness were to be employed to assess force and system effectiveness.

a. U.S. and opposing force casualties by direct and indirect fires.

b. Reaction to contact.

c. Time to complete mission.

d. U.S. and opposing force detections.

8. CONCLUSIONS: The following are strictly unofficial insights. The official report is scheduled for distribution in December 2000.

a. The Land Warrior unit assembled its combat power in 25% to 50% faster than a typical non Land Warrior unit.

b. Land Warrior soldiers and leaders were confident while moving at night.

c. Land Warrior capabilities facilitated aggressive reaction to contact. Leaders were able to verify and clarify the Blue tactical situation, eliminating an otherwise likely fratricide event.

d. Situational awareness area was limited due to limited communication ranges (100-150 meters in restricted terrain).

e. Battery life was longer than anticipated, but batteries posed a potential hazard.

9. OVERALL ASSESSMENT: This was the first major test of a working Land Warrior prototype. By all unofficial accounts, The TRADOC System Manager for Soldiers (TSM-S) is confident that the Land Warrior platoon scored high marks.

10. KEY FOLLOW ON REVIEWS TO THE STUDY: None noted.

1. NAME OF STUDY: Land Warrior Analysis of Alternatives Study Plan, 2001

2. DESCRIPTION OF STUDY (FOCUS): This plan identifies the resources and methodology to be used to perform an analysis of alternatives for the Land Warrior system. Land Warrior is designated as an acquisition category II program, and this study will support a milestone III decision scheduled for 3rd quarter, fiscal year 2003.

3. ISSUES (CONSIDERED, RESOLVED, UNRESOLVED):

a. What is the operational/combat effectiveness of each alternative?

b. What are the performance drivers of each alternative?

c. What are the training and logistical impacts of each alternative?

d. What are the life cycle costs of each alternative?

e. What is the force risk of the preferred alternative if Land Warrior procurement is reduced by various percentages (i.e., 10 percent, 20 percent, etc.)? What additional capability is gained through procuring more Land Warrior systems than planned? In the high-low mix excursions, are many lower technology systems more effective than a limited number of high technology systems?

4. MODELS AND SIMULATIONS (LIMITATIONS):

a. The Combined Arms and Support Task Force Evaluation Model (CASTFOREM). A high resolution, two-sided, force-on-force, stochastic, event sequenced, symmetric simulation model of a combined arms conflict.

b. Janus. An interactive, six-sided, closed, stochastic, ground combat simulation for platoon to brigade level, ground and air-ground combat simulation using conventional and chemical weapon systems.

c. Soldier Station. A distributed interactive, man-in-the-loop, virtual, dismounted soldier simulator with underlying constructive model algorithms for movement, detection, engagement, and damage assessment.

d. TRAC-WSMR Mix Model. Developed to help decision makers identify the individual systems and alternative systems that provide the optimal benefit for the cost by integrating the operational results of the TRAC-WSMR Mix Model with Army systems costs. The scenario analysis component of the model identifies the families of systems that provide the most combat effective benefit under varying constraints. The Decision Support System model computes a score for each alternative and family of alternatives based on the expected improvement in combat effectiveness over the base case.

5. SCENARIOS (LOCATION, TIME FRAME, BLUE AND RED FORCES):

a. Scenarios that stress the U.S. forces and Land Warrior alternatives will be used, and will include light and heavy forces and day and night operations under adverse conditions, to include MOUT operations. The scenarios will provide a means of examining the employment of the Land Warrior system in high resolution, force on force models.

6. ALTERNATIVES:

a. The baseline Infantry, forward observer, combat medic, and combat engineer will be equipped with current (2004) systems.

b. The U.S. Land Warrior force will be equipped with Land Warrior capabilities as defined by the Land Warrior operational requirements document.

c. Initially, offshore (foreign) alternatives will be evaluated using the system performance analysis conducted by the U.S. Army Materiel Systems Analysis Activity. Systems which meet the Land Warrior operational requirements will be further evaluated in the analysis of alternatives, to include effectiveness, training impact, logistics impact, manpower, and cost analyses.

7. MEASURES OF EFFECTIVENESS (MOE): The following measures of effectiveness were to be employed to assess force and system effectiveness.

a. Fractional exchange ratio. A ratio which compares the percentage of OPFOR killed to the percentage of US killed.

b. Loss exchange ratio. A ratio which compares the number of OPFOR killed to the number of US killed.

c. Specific exchange ratio. A ratio which compares the number of OPFOR killed by a specific US system to the number of that specific US system killed.

8. CONCLUSIONS: To be determined.

9. OVERALL ASSESSMENT: To be determined.

10. KEY FOLLOW ON REVIEWS TO THE STUDY: To be determined